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COMPARATIVE TRAINING CAPABILITIES AND TEST CONCEPTS FOR SELECTED TANK GUNNERY TRAINING DEVICES

ARI FIELD UNIT AT FORT KNOX, KENTUCKY

December 1982

U.S. ARMY RESEARCH INSTITUTE for the BEHAVIORAL and SOCIAL SCIENCES

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This research product was developed to assist in providing evaluation information about the following tank gunnery devices: Eye-Safe Simulated Laser Rangefinder (ESSLR), Conditionally Eye-Safe Simulated Laser Rangefinder (CESSLR), Multiple Integrated Laser Engagement System (MILES), TELFARE Tank Gunnery Sub-Caliber Trainer, and SAAB BT-41 Tank Combat Simulator. Comparative analyses were made of the devices (viz., ESSLR, CESSLR vs. Dry Fire; MILES, TELFARE, BT-41 vs. Dry Fire) to identify explicit capabilities, and to elicit factors that might suggest additional analyses or evaluation. Recommended test concepts and experimental designs are provided.

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COMPARATIVE TRAINING CAPABILITIES AND TEST CONCEPTS FOR SELECTED TANK GUNNERY TRAINING DEVICES

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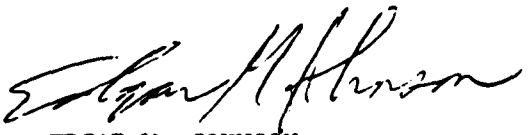
Training Simulation

FOREWORD

The Fort Knox Field Unit has a long history of successfully using the methodology of experimental psychology for solving Army training system problems. The simulation system team of this unit performs research and development on the effectiveness of devices, aids and simulations for improving Armor training.

Rising ammunition costs and other resource limitations have required the Army to consider increased use of simulation in conducting tank gunnery training. The development of special filters to protect eyes of soldiers from laser rangefinder emissions is a specific example. Another problem centers on the need to give tank crews experience firing and using proper procedures against free moving, intelligently controlled targets while operating under the danger of being "killed" themselves. A concept of such a training system is currently evolving. This system will develop, maintain, and objectively evaluate individual, crew, and unit proficiency in main gun skills.

This research product provides evaluation information about the following tank gunnery training devices: (1) Eye-Safe Simulated Laser Rangefinder (ESSLR), (2) Conditionally Eye-Safe Simulated Laser Rangefinder (CESSLR), (3) Multiple Integrated Laser Engagement System (MILES), (4) TELFARE Tank Gunnery Sub-Caliber Trainer, and (5) SAAB BT-41 Tank Combat Simulator. A previous research note, "Field Evaluation of the ESSLR and CESSLR Devices," focused on the ability of these devices to provide reliable range estimation data.



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COMPARATIVE TRAINING CAPABILITIES AND TEST CONCEPTS FOR SELECTED TANK GUNNERY TRAINING DEVICES

BRIEF

REQUIREMENT:

Rising ammunition costs and other resource limitations have required the U.S. Army to consider increased use of simulation in conducting tank gunnery training. For example, a recently developed simulation device, the Eye-Safe Simulated Laser Rangefinder (ESSLR), promises to ease the training burden by eliminating the need for eye-safe laser ranges. Another device, the SAAB BT-41, is an engagement simulation system that seeks to integrate main gun gunnery and tactical skills into one program. In the BT-41, tank crews receive explicit experience in firing and operating against intelligently controlled targets; they are subject to attack and destruction themselves. As with any simulation device, there is a need to evaluate the devices and to compare them with various training alternatives. That is the thrust of this research product.

PROCEDURE:

Available documentation on various devices and/or procedures for training soldiers in range determination were reviewed and comparative analyses made. The ESSLR, along with the Conditionally Eye-Safe Simulated Laser Rangefinder (CESSLR), was compared with Dry Fire Training. Dry Fire was viewed as done both with the unfiltered Laser Rangefinder (LRF) operating and without the LRF operating. In a second effort, the literature on three other devices was reviewed and comparative analyses undertaken. The devices employed were SAAB BT-41 Tank Combat Simulator, Multiple Integrated Laser Engagement System (MILES), and TELFARE Tank Gunnery Sub-Caliber Trainer. They were compared with Dry Fire Training in a force-on-force engagement situation.

FINDINGS:

It was judged that all tasks related to range determination could be performed using the ESSLR and CESSLR devices, with only minor exceptions. While these devices require that the target be enhanced with appropriate retroreflective materials, their eye-safe feature compensates for this inconvenience. A test concept to guide the gathering of more explicit data on the performance of the two devices was prepared.

The comparison of the BT-41, MILES, and TELFARE with Dry Fire Training led to these conclusions: (1) Dry Fire Training is a viable training option in either firing range gunnery practice or force-on-force engagements only when no other training alternative is available; (2) Since the TELFARE uses live ammunition, its use should be limited to gunnery range practice; (3) While both MILES and BT-41 can be used in firing range gunnery practice and can simulate force-on-force engagements, the BT-41 has certain features that appear to make it superior. These include real time engagement,

presentation of projectile path, display of strike of round, and true sensing of round impact. A test concept to guide the evaluation of the BT-41 and MILES in both firing range phases and in a set of force-on-force engagements was prepared.

UTILIZATIoN:

The test concepts presented here provide explicit guidance to armor agencies wishing to conduct further evaluations of the devices.

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COMPARATIVE TRAINING CAPABILITIES AND TEST CONCEPTS FOR SELECTED TANK GUNNERY TRAINING DEVICES

OVERVIEW

The rising costs of tank main gun ammunition, fuel, and spare parts have necessitated an increasing reliance on substitute, miniaturized, or simulated forms of practice in tank gunnery training. The goal of many of these innovations is to provide effective practice opportunities to individual crewmen. Other approaches focus on entire crews and platoons and seek to provide tactical training as well as gunnery training.

The present report examines various training alternatives, both for developing individual tank gunnery skills, and for perfecting tactical tank gunnery capabilities. It suggests some criteria by which to compare the several devices, and proposes some dimensions or factors that are believed to be relevant to future device comparisons. The report contains four separate papers. Their titles are:

An Analysis of the Training Capabilities of the ESSLR and CESSLR Devices Compared With Dry Fire Training

Test Concept for a Comparative Evaluation of ESSLR, CESSLR, and LRF in Dry Fire Training

An Analysis of the Training Capabilities of the SAAB BT-41, MILES and TELFARE Devices Compared With Dry Fire Training

Test Concept for a Comparative Evaluation of SAAB BT-41 and MILES Training Device

AN ANALYSIS OF THE TRAINING CAPABILITIES OF THE ESSLR AND CESSLR DEVICES COMPARED WITH DRY FIRE TRAINING

There is a continuing need in the U.S. Army for the tank crewman to attain and maintain tank gunnery skills. However, the rising costs of tank main gun ammunition, fuel, and spare parts make it difficult to provide as much live fire training as is needed. As a partial solution, dry fire training is often utilized. With respect to laser equipped tanks, two kinds of dry fire training may be considered, one with use of the Laser Rangefinder (LRF) and one without the LRF. Both kinds of training would be performed without the loading and firing of live ammunition. Dry fire training has been useful, but when it is conducted with the LRF, the need for a laser safe range is a continuing problem.

In an effort to surmount the eye safety hazard of the LRF, two special filters were developed. One filter, called the Eye-Safe Simulated Laser Rangefinder (ESSLR), is completely safe; the other, called the Conditionally Eye-Safe Simulated Laser Rangefinder (CESSLR), is safe beyond a specified distance (300m unaided vision; 3100m aided vision). These filters are mounted over the exit window of the LRF.

A field evaluation of the range estimation capability of the LRF with each filter was recently undertaken (Melching, Osborn, and Bessemer, 1981).[1] The results showed that each filter could range satisfactorily under specified conditions of target reflectivity. An immediate need now is to compare gunnery training (a) as conducted with the filter devices, and (b) as done in dry fire training.

METHOD

Making the comparisons began with the identification of those tank gunnery tasks on which the LRF or filters might impact. Since the LRF and the filters pertain to ranging tasks, this aspects of tank gunnery actions provided the primary focus of the comparison. Further, since information about the capabilities of the two filters was obtained when they were mounted on the LRF of the M60A3 tank, the Operator's Manual for this tank (TM 9-2350-253-10) was used to identify the relevant tasks for the present comparison.

Once a tentative list of tasks was developed, the action elements of each task were carefully examined and a judgment made about any interaction between the task and each training device (ESSLR, CESSLR and Dry Fire). This basic question was asked: Can this task be performed on this device? Some tasks, of course might yield qualified answers and such an outcome was anticipated.

RESULTS

Appendix A provides the basic data of the comparisons. It is a matrix of tasks and devices; a judgment is shown in each intersecting cell with

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[1] Melching, W. H., Osborn, W. C., and Bessemer, D. W. Field Evaluation of the ESSLR and CESSLR Devices. Research Note 81-23, US Army Research Institute for the Behavioral and Social Sciences, August 1981. (AD A126 144)

respect to the question: Can this task be performed on this device? Judgments are in two categories:

Yes, task can be performed.
No, Task cannot be performed.

In addition, qualified judgments are designated by superscript digits. The interpretation of these qualifications is given at the end of the Appendix.

Certain assumptions were adopted before the several comparisons were made. These assumptions were: (a) Targets would be both moving and stationary; (b) Targets would be enhanced with retroflective materials, except when the unfiltered LRF would be used; (c) The ESSLR and CESSLR devices would be used in conjunction with live fire; and (d) Two Dry Fire Conditions would be included in the comparison, one without the LRF and one with the unfiltered LRF operating.

Findings from Task/Device Matrix

The results of the comparisons (see Appendix A) showed that all tasks could be performed when the ESSLR or CESSLR devices are used, with certain qualifications. With respect to the ESSLR, there are only two minor qualifications: (1) To perform the task "Clean LRF lens," the filter must be removed, and (2) The Task "Evaluate range data" may be a problem to perform, depending on whether multiple returns are received; at present it is uncertain that ESSLR will yield such returns. Various conditions may influence multiple returns, for example, distance to target, location of reflective materials on target, how well gunner is able to lay on these materials, proportion of target that is exposed, etc.

The CESSLR device shares these two qualifications and has another: A laser-safe range is required if the gunner is to "Perform LRF Firing Test," and "Range to Target." If it is assumed that the device is to be used in conjunction with live firing, then it is likely that a laser-safe range is available. The need for such a range for the CESSLR device and not for the ESSLR is due to the relative safety of the two devices. ESSLR is completely eye safe, while CESSLR is eye safe only at specified viewing distances.

Under Dry Fire Training Without LRF, several tasks cannot be performed. Included are "Perform LRF Firing Test," "Evaluate Range Data," and "Sense Round," plus the four malfunction test steps. The accomplishment of related tasks is also distorted. Thus, the gunner can press the appropriate switch to "Range to target," but he will receive no feedback. Similarly, the gunner can fire a simulated round, but he cannot meaningfully "Apply BOT" or "Apply TC adjustment."

Under Dry-Fire training with the unfiltered LRF operating, one task cannot be performed (Sense Round), and several others are contingent on the availability of a laser-safe range (e.g., Range to Target). Still other tasks can only be simulated (Fire Round, Apply BOT, Apply TC adjustment).

Related Matters. The use of reflective materials may be of particular assistance to gunners as they practice ranging to targets, especially for near range targets. The ESSLR field test showed that a gunner could lay on or lay off the reflective material on a target, and obtaining or not obtaining a return depended on which he did. Thus, the reflective material can give the gunner a specific aim point, and over time, should improve his aiming skill. Note, however, that when the gunner may subsequently have to range to an unenhanced target, the absence of reflective material on which to aim may lead to a deterioration in his performance. This may also be the case when the gunner seeks to relay on a target after a live round has been fired. Obscuration may prevent the gunner from laying on the reflective material, i.e., finding his aim point.

Ranging to a moving target may elicit special problems, depending on whether the system is in automatic lead or in a degraded mode. In the former, lead information must be dumped if the gunner reranges, and in the latter, manual lead must be maintained. More importantly, practice in ranging to moving targets may provide good feedback to the gunner about his tracking skill.

Related to the above is the matter of doctrine regarding aim point. If the gunner is to use base of target, then reflective materials must be mounted on the base when the ESSLR/CESSLR devices are used. This is probably not so important when the aim point is center of mass where the laser beam may, depending on range and placement of reflectors, encompass more than one piece of reflective material.

The recently completed ESSLR/CESSLR field evaluation did not employ live ammunition. Thus, while the specific effect of live fire on the reflective materials is not known, damage and deterioration may be predicted. This will likely affect the kinds of returns that are received since partially shot up targets will have holes through which the laser beam can pass. This can then lead to multiple returns or false readings.

Other Evaluation Criteria

In addition to comparing the devices in terms of tasks and task elements, a comparison of devices was also made in which the focus was on conditions under which training might occur. This comparison excluded live fire training and examined dry fire training as conducted with three devices: ESSLR, CESSLR and LRF. Dry fire training without the LRF was also included although it is questionable that a meaningful comparison with it is possible.

Making comparisons among the devices began with the development of a list of performance conditions under which the devices might have to operate. These conditions were believed to be significant factors by which the potential usefulness of a training device could be evaluated. The method used, therefore, was rational: The researchers compared the devices by judging how well each device satisfied a given condition. These judgments were based on previously demonstrated capabilities of the ESSLR and CESSLR devices, and upon the current tank gunnery system. The performance conditions or factors on which the devices were compared and the results of the comparisons are presented below.

CONDITIONS OR FACTORS	DRY FIRE TRAINING			
	With ESSLR	With CESSLR	With LRF	Without LRF
Effective with unenhanced targets?	NO	YES	YES	NA
Effective with enhanced targets?	YES	YES	YES	NA
Safe to operate anywhere?	YES	NO	NO	YES
Special range required?	NO	YES	YES	NO
Multiple returns received?	NO	YES	YES	NO
Operate same as regular LRF?	YES	YES	YES	YES
Feedback provided?	YES	YES	YES	NO
Safe to use in force on force exercises?	YES	NO	NO[1]	YES
Interoperable with MILES?	YES	YES	YES	YES
Range estimates accurate?	YES	YES	YES	NO
Base of target an acceptable aim point?	YES	YES	YES	YES

[1]Can be used only with laser safety goggles, on a laser safe range.

Each judgment of a factor for a device was YES or NO except in the column "Without LRF." Some factors here were judged Not Applicable, and the letters NA were employed to denote this. Also, some YES judgments in this column are probably meaningless.

In other columns the judgments of YES or NO may not be clear cut. For example, ESSLR may produce multiple returns, but this is yet to be established. Also, range estimations with the ESSLR are accurate except when the target, enhanced with a corner cube prism, is placed at a distance less than 1000m. At near distances the prism tends to reflect the laser beam twice, thereby doubling the range estimation.

At this time, it is uncertain how reflectors may be mounted when ESSLR is used in force on force engagements. Thus, no special prediction is provided regarding possible negative or positive effects of the filter.

CONCLUSIONS

It was judged that all tasks related to range determination could be performed using the ESSLR and CESSLR devices, with only minor exceptions. While these devices require that the targets be enhanced with appropriate retroreflective materials, their eye-safe feature compensates for this inconvenience. Although the details of this analysis apply only to the M60A3, the results should largely generalize to the M1 which has a very similar fire control system.

TEST CONCEPT FOR A COMPARATIVE EVALUATION OF ESSLR, CESSLR, AND LRF IN DRY FIRE TRAINING

Dry fire tank gunnery training can be conducted in two ways, one with the Laser Rangefinder (LRF), and one without the LRF. When the LRF is used, a laser safe range is required. On the other hand, when the LRF is not used, a special range is not needed, but the trainees gets only simulated practice in ranging. A great difference in these two circumstances centers on the kinds of feedback that are provided to the gunner.

In the With LRF condition, feedback can be provided by the TC. He remains silent when the range determination is acceptable, and he asks the gunner to rerange when he feels the determination is in error. In the Without LRF condition, feedback can be provided by the TC, not with respect to the range determination, but with regard to acceptability of aiming point or sight picture. While these two kinds of performance feedback are different, they can be used to score the ranging performance of a gunner.

With the development of two special filters, one called the Eye-Safe Simulated Laser Rangefinder (ESSLR), and the other called the Conditionally Eye-Safe Simulated Laser Rangefinder (CESSLR), it is possible to conduct dry fire training with these filters, thereby reducing the safety hazards due to the LRF, and at the same time, giving the gunner concrete practice in ranging to targets.

To determine the effects of the various devices on training effectiveness and transfer effectiveness, a study should be done in which trainees receive controlled amounts of practice on one of the training devices and are then tested on the system device. In the present case, the With LRF is the system device, thus, performance on it constitutes the criterion.

METHOD

Subjects

Soldiers undergoing BAT-OSUT training should serve as subjects. Since there are three training devices or conditions (ESSLR, CESSLR, and Without LRF), three groups of soldiers will be needed. Ideally, sixty soldiers or more should be made available, thereby permitting a minimum of twenty subjects in each group.

Equipment, Material, and Personnel

The following equipment, materia , d personnel will be needed.

1. Laser-safe range
2. 2 M60A3 tanks, equipped with AN/VVG-2 LRF, plus crews
3. 1 Improved TOW vehicle (ITV), with crew

4. 4 8' x 8' panel targets

5. Radiometer Indicator Unit, Model 581-15, mfd. by EG&G, with operator

6. 2 ESSLR and 2 CESSLR filters, plus 2 Gain Enhancement Plugs

7. Retroreflectors and reflective materials, as follows:

   (1) 1 roll Uncoated Sheeting, 2" wide (3M High Gain Sheeting No 7210)

   (2) 1 roll Coated Sheeting, 2" wide (Scotchlite High Intensity Sheeting No. 3870)

   (3) 30 Molded Plastic Discs, 3" diameter (3M Reflectolite Reflectors)

   (4) 1 Corner Cube Prism (2 3/4" diameter, Valtec No. V101)

8. 1 Stapling tool

9. 1 Glue gun

10. Electrical extension cords (200 ft.)

Procedure

The general sequence will be as follows: Pretest all subjects, administer the training to each group, and then administer the posttest.

Pretest. The pretest will consist of 15 range determination trials using the unfiltered LRF with unenhanced targets. The sequence of target distances and target orientations (angles) is as follows:

Trial No.	Target Distance (m)	Target Angle (°)
1	500	0
2	1100	45
3	700	30
4	600	45
5	1150	0
6	300	45
7	1200	30
8	750	45
9	800	0
10	950	30
11	900	30
12	1000	45
13	1050	0
14	650	0
15	400	30

Subjects will be instructed to lay on center of mass of target. The range determination reported by the LRF will be recorded for each trial, including multiple returns, as received. Range determinations that are within 10m of actual range will be recorded as correct. Time to range after the fire command will be recorded by the tank commander using a stopwatch.

Training. As subjects complete the pretest they will be randomly assigned to a group. Groups will be equated in practice in ranging to targets, that is, each group will experience the same number of targets, target distances, and target angles. The difference will be that ESSLR and CESSLR groups will range to enhanced targets, while the Without LRF group will simulate ranging to unenhanced targets. These subjects will press the laser switch but it will not send out a beam.

Each subject will be given 40 training trials with targets at 300 to 1500m; the spacing should produce a total of 20 discrete distances. A constant set of distances and target angles will be generated and used. For ESSLR and CESSLR groups, targets will be enhanced as follows:

No of Targets	Reflectivity	Spacing
10	Coated	Strips 6" apart, center to center
10	Uncoated	Strips 6" apart, center to center
10	Molded	Discs 6" apart, center to center
10	Prism	One only, center of target

Targets enhanced by a prism must employ target distances of from 1000 to 1500m only.

ESSLR and CESSLR subjects will receive the feedback normally provided (as when LRF is used), while Without LRF subjects will be given feedback from the TC with respect to acceptability of aim point. Trainees will lay on the center of mass of target, and ESSLR/CESSLR subjects will be encouraged to lay on a section of reflective material when it is located in or near the center of mass.

Posttest. The posttest will consist of two parts: (a) the same 15 range determination trials given in the pretest, and (b) an additional 15 trials. The latter trials will encompass range distances varying between 1250 and 1900m; spacing of these targets should be in 50m steps, with some distances repeated if necessary. Instructions and scoring will be as in the pretest.

Target Visibility. Not considered above in training and testing procedures is the amount each target is exposed. Since partially exposed targets are more realistic, and since reduced exposure increases the chances of multiple returns, it is recommended that all targets (both training and

testing) be positioned so as to be partially exposed (25-50%). In locating targets in suitable terrain and vegetation, care must be taken not to place a target in the same position for testing as it was during training.

Evaluation

To examine relative training effectiveness, the mean scores of all groups on the 40 learning trials can be compared in successive blocks of ten trials by repeated measures ANOVA. The score for each subject in each block amounts to a tally of the number of instances in which his determination (or aim point) was acceptable to the TC.

Information about transfer effectiveness would come from comparing the pretest mean of each groups with its part a posttest mean. A more complex between and within mixed design ANOVA could be used to evaluate both parts a and b of the posttest results.

Extensions

If resources and time permit, the test should be repeated to examine training with moving targets, and with multiple returns. In the case of moving targets, virtually the same test procedure can be followed, with moving target ranges in the test selected for training and test according to what is feasible on the available range. If an ITV can be used as a moving target carrier, a variety of target speeds can be presented, and speed can be included as an independent variable in the ANOVA. It would also be desirable to include a new group of soldiers, who received the moving target training without the prior stationary target training. This would permit the examination of the effect of stationary target training on transfer in the moving target ranging conditions.

A test of multiple return training can be conducted using a similar procedure. However, the participants in this case are tank commanders (TC's) with the focus on their decision making performance. Expert gunners who serve throughout the test should perform the initial ranging for each TC decision. Reflective materials should be mounted on poles at several positions in front of and/or behind the target to provide multiple returns on a predetermined basis. Materials on some poles should be arranged to appear to provide possible returns, but be offset, or slightly angled, so they will not give returns. This will require the TC to base his judgment on his estimate of target distance, rather than a simple count of the poles. The exact ranges used would depend on what can be feasibly set up on a given range. Dependent variables (performance measures) should include (1) number of correct range selections, (2) average error of ranges selected, and (3) decision time from the return to pressing the FEED button. In this study, a control group receiving no training should be used instead of the dry fire condition.

Addition of these two studies to the test would provide a much more comprehensive evaluation of the potential contributions of the devices to the total gunnery program. However, a decision to field the filter devices is supportable based on positive results from the first test alone.

AN ANALYSIS OF THE TRAINING CAPABILITIES OF THE SAAB BT-41, MILES AND TELFARE DEVICES COMPARED WITH DRY FIRE TRAINING

Continuing resource restrictions have worsened the problem of an annual peak of gunnery proficiency followed by off-season proficiency slumps. Simulated non-firing crew drills, subcaliber firing and actual main gun firing are the current methods of attaining gunnery proficiency. REALTRAIN and MILES provide a means of tying weapons lethality to tactical maneuver exercises. However, neither the current gunnery programs nor current engagement simulation systems require the complete integration of main gun gunnery and tactical skills into one program; nor do they provide a realistic, cost effective means of maintaining year round weapons system proficiency. Gunnery training should be given in the context of tactical training to give crews experience firing and using proper procedures against free moving, intelligently controlled targets while operating under the danger of being "killed" themselves. In addition, there is a requirement to analyze errors and provide accurate evaluation of tank crews.

A concept of a Tank Weapons Gunnery Simulation System (TWGSS) is currently evolving. This system will develop, maintain, and objectively evaluate individual, crew and unit proficiency in main gun skills, including their ability to boresight and zero. TWGSS will be used to provide realistic simulation of any main gun firing table to include individual, crew, platoon, company, and battalion exercises. The system will interface electronically and mechanically with the M60A1, M60A3, M48A5, and M1 tanks. It will be interoperable with the Eye-Safe Simulated Laser Rangefinder (ESSLR). The TWGSS concept at this time does not consider the Commander's weapon, coaxial machinegun, or loader's machinegun simulation.

The system envisioned for development shall integrate the main gun weapon system with simulation to provide training in the acquisition, engagement, and adjustment of fire upon stationary and moving land targets by a stationary or moving firing tank. It shall operate by calculating the exterior ballistics of simulated main gun rounds as a function of the initial velocity vector which is determined by the location of the gun tube in space, and the characteristics of the ammunition being simulated.

DEVICE DESCRIPTIONS

Certain devices are candidate systems to satisfy the TWGSS concept needs described above.* A brief description of each device is provided. The capabilities of these devices will subsequently be compared with Dry Fire training as it would be conducted on the M60A1, M60A3, M48A5, or M1 tank.

MILES Tank Gunnery Simulator

The Multiple Integrated Laser Engagement System (MILES) is a Combat simulation training system which provides the armor unit with realistic fire

*In this study, "device" and "system" are used interchangeably.

and maneuver exercises. Tank leaders and crewmen are called upon to make decisions when opposed by a constantly reacting enemy under actual terrain and weather conditions.

The MILES system provides weapons effects simulation for all tank weapons. It is capable of simultaneous engagements. MILES provides signature simulation through the use of sound and flash devices. Weapon mounted laser transmitters are boresighted/zeroed with the tank weapon sights. Firing of the weapon causes simultaneous signature simulation and the transmission of eye-safe invisible pulses of laser energy which duplicate the effects of live ammunition. Detectors are mounted on the front, sides, and rear of the tanks.

When a tank mounted sensor detects a laser transmission from another firing tank gun, the vehicle logic module determines whether the tank was near missed, hit without catastrophic result, or destroyed. Visual and auditory indicators on tanks emit signals which make the target aware that it has been hit or missed. A flashing light on the target tank's exterior provides information to the firing tank's crew, while a buzzing tone over the intercom system provides information to the crew of the target tank that it has been fired upon. MILES is designed primarily for employment in unit OPFOR exercises.

TELFARE Tank Gunnery Sub-Caliber Trainer

The TELFARE tank gunnery device is a main gun, sub-caliber, strap-on mount which utilizes the Cal. 50 M2 Heavy Barrel Machinegun as a substitute for 105mm ammunition. It is a main gun simulator only. The device can be used at full scale firing ranges mounted on the gun tube of the M60A1 tank as well as other tanks. It fires single shot Cal. 50 M20 Armor Piercing Incendiary Tracer Ammunition (AP-I-T). Ammunition is loaded in the machinegun from outside the tank prior to the commencement of the gunnery training exercise. The pull cable assembly provides the loader with the capability of charging the gun from his hatch.

The device is accurate out to 1000 meters, after which accuracy gradually diminishes. It is recommended primarily for use on 1/2 scale ranges using 1/2 and full scale targets. Since there is no subcaliber CAM for this device, the HEAT Cam is recommended.

Functional Description: The device consists of the following: (1) mount assembly; (2) traversing and elevating mechanism; (3) strap assembly; (4) pull cable assembly; (5) solenoid; (6) controller assembly (single shot device); and (7) wiring harness assembly. The device is wired to the control firing circuit and is fired by the gunner's firing trigger. The single shot device insures that only one round is fired each time the trigger is pulled.

SAAB BT-41 Tank Combat Simulator

The SAAB BT-41 Tank Combat Simulator is a tank-appended gunnery trainer which can be utilized in tactical combat exercises in a force-on-force

application. It is a main gun simulator only. The system provides simulation of shots fired and evaluation of hit-effects on targets. It allows shooting while in motion and shooting at moving targets. It also provides a natural feedback to the tank commander and gunner. The major components are:

1. Fire Simulator: The characteristics for the Fire Simulator are that an electronic projectile is simulated in real time to follow a ballistic trajectory in true space and that the relative position between the projectile and a target reflector is measured. A Fire Simulator consists of: Fire Computer, Laser Unit, Display Unit, Printer Unit, Tracer Unit (one unit optional for the commander), Adaptation Set, to include necessary attachments, etc., peculiar to the model of the firing tank upon which the Fire Simulator is to be mounted. The Adaptation set also consists of fittings for the units, cables cut to appropriate lengths, and mechanical and optical interfaces for the Tracer unit. A Gunfire Simulator with pyrotechnics is optional.

2. Target Simulator: The characteristics for the Target Simulator are that the hit-effect is calculated and indicated in the target vehicle. This provides the possibility to indicate the effects to the gunner, since he can observe the target behavior as in real combat. In addition, the progress of a tactical exercise can be affected by achieved hit results. A Target Simulator consists of: Target Computer, Reference Modules, which detect hits (each covering a 90° arc), Optional Hit Indicator (either light or pyrotechnics), Printer Unit (which may be connected to the Fire Simulator), and Adaptation Set for mounting on the particular model of vehicle being utilized as a target.

Assumptions

In planning the procedures to be used in comparing the devices, certain important assumptions were adopted. These assumptions are as follows:

1. While devices should be compared both in terms of their capabilities to train individuals in pure gunnery practice and to train crews in force-on-force engagements, it is assumed that an emphasis should be placed on the latter capability.

2. In force-on-force engagements, it is assumed that the ESSLR filter can be used on all tanks that are equipped with the laser rangefinder.

3. When the ESSLR filter is used for range determinations in lieu of the regular laser rangefinder, it is assumed that all targets will be enhanced with appropriate reflective materials.

4. It is assumed that the ESSLR beam will not interfere with or prevent the action of laser fire simulators in the BT-41 or MILES, and that the reflective materials needed by the ESSLR will not interfere with the required actions of these devices.

METHOD

Document Review

Procedures used to accomplish the comparison of devices began with the preparation of a special matrix. Placed vertically, on the left side, was a set of performance elements (crew tasks or actions), and placed horizontally, across the top, were the names of the devices to be compared. In each intersecting cell a judgment was then made as to whether the performance element could be performed on the associated device. Judgments were based on information in device documents and on opinions of armor experts.

In developing the matrix, a list of performance elements had to be generated, and the characteristics and capabilities of each device had to be reviewed. As a first step, therefore, various documents that suggested tasks or actions that might be meaningful to include in the present comparison effort were reviewed. Also reviewed at the beginning were documents that provided detailed descriptions of the several devices.

Reviewed documents included:

1. System Specification, SAAB BT-41, Tank Combat Simulator. SAAB-SCANIA AB, February 13, 1980.

2. Resume Sheet for CEP Testing, SAAB BT-41, Tank Combat Simulator, USAARENBD, March 10, 1980.

3. Training Device Letter of Agreement for Tank Weapon Gunnery Simulation System (TWGSS), USAARMC-DTD, October 20, 1980.

4. SAAB BT-41 Tank Combat Simulator, brochure, SAAB SCANIA.

5. How to Plan, Prepare, and Conduct MILES Training, TC 71-4 Coordinating Draft, September 22, 1980.

6. MILES NETT Lesson Plan #002.

7. Tank Gunnery Devices, FM 17-12-7, June 17, 1977.

8. Catalog of TASC Training Devices, DVC-D 17-88.

9. M60A1AOS Tank Gunnery Data Handbook, ARI Technical Report TR 79-A7, March 1979.

10. Operator's Manual, TM 9-2350-253-10, November 1979.

11. Tank Gunnery, FM 17-12-2, March 1977.

12. Sustainment of Tank Gunnery Proficiency Under Conditions of Reduced Main Gun Ammunition Allocation, US Army Armor School, ST 17-12-2-1, February 1979.

In developing the list of performance elements, candidate tasks or actions were considered only if, in the opinion of the staff, they were patently relevant to main gun firing. This limitation is consistent with the TWGSS concept. Thus, not included were performance elements associated with firing the COAX and the Commander's weapon (50 Cal. MG), since these weapons do not involve the main gun. The performance actions of all crew members were included at this time even though it was anticipated that some device comparisons might not be feasible for some positions.

From examination of the documents, it appeared that the last document listed above (ST 17-12-2-1) provided a list of crew duties or performance elements that could be most helpful in comparing the devices. The performance elements listed in the ST are "for each of eight types of gunnery tasks and engagements which represent the types of engagements encountered on standard FM-17-12 series-tank tables." Thus, the ST made available a comprehensive list of elements. There was another merit to this document: It provided judgments of armor experts of the capability of various devices.

Since the judgments of the capabilities of the devices were to be based on device documents and on opinions of armor experts, use of this document to derive performance elements supplied a ready-made set of expert judgments about three of the devices: TELFARE, MILES, and Dry Fire training. Other judgments about these devices were to be obtained, as well as judgments about the BT-41.

Each judgment made in the present comparison was substantially of the same type as that given in the ST: Can this task (action or performance element) be performed on this device? In making the present judgments, the research staff examined each judgment in the ST and then, based on all the sources, agreed or disagreed with it. This procedure provided judgments on all performance elements for three devices: TELFARE, MILES, and Dry Fire training. The remaining judgments for the BT-41 were made separately, but they too were based on existing documents and opinions of armor experts.

Opinions of Armor Experts

The judgments of performance elements found in the ST document constitute one source of armor expert opinions. In addition to these expert views, information and opinions were also obtained from two experts at the US Army

Armor and Engineer Board, Fort Knox, Kentucky. Specifically, these persons were asked to review the judgments in the initial matrix of elements and devices and to express their agreements (or disagreements) as they felt appropriate. Their opinions were sought especially with respect to the SAAB BT-41, but they were also invited to make comments with regard to judgments on other devices as they felt capable.

The opinions of these experts were also sought with respect to important system characteristics beyond those considered in the performance elements matrix. The nature of these additional characteristics is described in the following section.

Additional Evaluation Criteria

In reviewing the various documents and preparing the matrix of performance elements and devices, it became apparent that factors other than these elements were relevant in comparing the capabilities of the devices. These factors consisted of matters that may be called, variously, system goals or objectives, system performance criteria, conditions under which a system must perform, or system requirements. A list of these factors was prepared and the capabilities of each device were then rated for each factor. A rating on a factor consisted of answering the question: Does the device incorporate or embody this factor? As before, ratings were based on device descriptions and on opinions of armor experts. The list of factors and associated ratings are presented at the end of the previously described matrix.

RESULTS

Performance Elements Matrix

This matrix is found in Appendix B. It contains the specific judgments made for each device (system) on the several performance elements. For convenience, the performance elements are clustered into crew member duty stations. While specific judgments of an element across devices can be obtained by examining the matrix, general comments are presented below.

Driver Station: A cursory glance at the judgments in the intersecting cells indicates that the performance elements of the Driver were not greatly influenced by a change from one system to another. There are, however, two performance elements of the driver that differ substantially among the gunnery systems. Both the SAAB BT-41 and the MILES systems fire a simulated projectile; indications of success or failure of the engagement are provided to both of the opposing tanks in a force-on-force type exercise. This brings a comparatively new dimension to gunnery and tactical training for armor units. Two driver tasks (Take evasive action to avoid enemy fire; and Seek cover, concealed, or defilade position) assume particular significance for MILES and SAAB BT-41. They do differ, however. When the MILES attacking tank fires and hits a target tank, there is an <u>immediate</u> indication of the hit in both tanks. This is because the MILES "projectile" flies at the speed of light. For the BT-41, time of flight is controlled, and hit indications are more accurately timed. With the latter system, evasive action by the

driver may be feasible, and the task impacts more realistically on training. In contrast, this kind of action is much less feasible in the MILES system. Finally, this kind of action is assumed to be not relevant in Dry Fire or in TELFARE.

Loader Station: Loader performance elements indicate some degree of difference in training capability among systems. When utilizing the Dry Fire training method, after the dummy cartridge is loaded and the loader has indicated "UP," there is no further action that the loader can take until a new engagement is initiated. Subsequent rounds must be simulated and the dummy cartridge extracted before further training can be given. An examination of the loader's performance elements while training with the TELFARE device indicates some different shortcomings. Since the TELFARE device is mounted on the main gun tube outside the tank and is loaded before the engagement begins, there is little action that the loader can take during the target engagement. He can go through sequences involving the main gun safety switch, the turret blower, and the loading of a dummy cartridge, but his actions will not affect the success of the engagement. The MILES and BT-41 systems have similar effects on the loader's duties. Since a main gun round is not fired, the loader must manually move the safety switch to the safe position before simulating the loading of a subsequent round. If a dummy cartridge is loaded in the main gun, it must be extracted before further loading is done.

Gunner Station: A review of the gunner's performance elements indicates that the gunner's tasks in Dry Fire training are the same as those in actual fire up to the task "Sense round." After that point, tasks must be simulated by the gunner. Examination of the gunner's actions while using the TELFARE device shows that his actions are the same as those performed utilizing main gun ammunition except that HEP ammunition must be indexed, and that the HEP reticle must be used in the secondary sight. Because of this, proper lead angle is not provided when engaging moving targets. The TELFARE device is also limited in effective range to about 1,200 meters. Rounds can be sensed and subsequent rounds fired as with main gun ammunition, but this device has no force-on-force application. Gunner's actions while utilizing the MILES system indicate that while this system is very effective as a tactical force-on-force training system, it leaves something to be desired since the tank computer must be turned off. MILES is primarily a battlesight gunnery device, however, a precision aiming technique (lay on center of mass of the target) is most effective. Battlesight aiming technique (lay on base of target) may not produce target hit effects due to the placement of hit/kill sensors on the turret. In contrast, when the tank gunner operates in the SAAB BT-41, his duties in precision and battlesight gunnery are similar or identical to those required for live main gun firing.

Tank Commander Station: The tank commander's tasks for Dry Fire training, like those of the gunner, remain unchanged from actual main gun firing until the task "Sense round." After that point, duties must be simulated. When utilizing the TELFARE device, he must index 1,000 meters into the rangefinder since only the HEAT cam can be used. His subsequent actions remain unchanged. The limitations placed on the tank commander when he uses the MILES system are similar to those imposed upon the gunner. Battlesight gunnery is somewhat degraded, and improper lead angle (with the computer off)

may be a problem while engaging moving targets. In contrast, the SAAB BT-41 simulator system requires little change in performance elements from those required for live fire.

System Criteria Matrix

This matrix is found in Appendix C. It presents the specific judgments made for each device on the various system criteria. A summary of the findings is presented below.

A. System Can Be Used in Force-on-Force Gunnery Engagements. Two of the four systems, SAAB BT-41 and MILES, are capable of force-on-force tactical gunnery exercises. Since the BT-41 does not simulate the coaxial machinegun or the commander's (50 Cal.) machinegun, tank crews cannot conduct simultaneous engagements. The MILES system is designed to be used primarily in the force-on-force role, while the BT-41 is designed to be equally capable of training crew interaction tank gunnery as well as force-on-force application.

B. System Can Be Tank Appended and Aligned By the Crew In One Hour. The SAAB BT-41, MILES, and the TELFARE devices are all tank appended. The TELFARE device can be mounted in a very few minutes by simply clamping the 50 Cal. machinegun mount on the main gun tube and attaching the firing solenoid. The time criterion for mounting the MILES equipment on a tank is 30 minutes. Installation of the BT-41 equipment can be completed in less than one hour. These times do not include the times necessary to boresight or zero the equipment.

C. The Tank Can Be Restored to Operational/Firing Condition in 1/2 Hour. Tanks with any of the gunnery simulator systems can be restored to operational/firing condition within 1/2 hour. Combat boresight will have to be restored after a device has been removed from the tank.

D. System Does Not Interfere With Normal Movement of Vehicle or Turret. All of the gunnery simulation systems are compatible with the normal movement of the tank; this includes the traversing, elevating, and depressing of the main gun.

E. System Does Not Interfere With the Performance of Crew Duties. All of the systems (devices) interfere with the performance of crew duties to some extent. The requirement to perform particular performance elements varies among simulation systems. Dry Fire crew tasks end with the simulation of firing the first round. TELFARE crew tasks are limited by the lack of responses from the target and the artificiality of being limited to HEP ammunition. As noted earlier, the MILES system modifies some crew duties as a result of the tank computer being shut off. The BT-41 interferes the least with crew duties normally required for main gun firing.

F. Capable of Withstanding Both Hard Surface and Cross-Country Travel. The TELFARE device is less sensitive to travel through heavy undergrowth than is the MILES or BT-41 systems; the latter have components appended in several locations on the outside of the tank. All systems are capable of sustaining normal cross-country travel.

G. System Does Not Present a Health or Safety Hazard. None of the systems present a health or safety hazard if the equipment is properly employed. Since the TELFARE device utilizes 50 Cal. machinegun ammunition, usual range safety regulations must be followed. Both MILES and BT-41 use eye-safe laser devices.

H. Fire Upon Stationary and Moving Targets From a Stationary and Moving Tank. All systems are capable of firing at a stationary or moving tank. Capabilities and limitations of the tank fire control system determine the mode of firing. Since the MILES system does not simulate a trajectory path, no lead is required to hit the target. For proper transfer of training, the BT-41 and TELFARE devices are better simulation systems when used with fire control systems that do not have automatic lead.

I. Use or Simulate the Function of All Direct Fire Control Equipment. All fire control equipment is not used by all of the simulation systems. The MILES system, for example, is employed with the tank computer shut off. The BT-41, on the other hand, is compatible with the tank fire control system, and the tank's computer can be utilized. When using the TELFARE device, HEP ammunition only can be indexed. With the secondary sight the HEP reticle must be used.

J. Operate Under the Same Visibility Conditions As the Tank Upon Which the System is Used. All systems can operate under the same visibility conditions as the tank itself. None of the systems have components which are designed specifically for night use or under conditions of poor visibility.

K. Operational Out to 3,000 Meters Under Ideal Conditions of Visibility. The BT-41 is operational under ideal conditions of visibility out to a range of 3,000 meters. The MILES system has a kill range out to 2,400 meters. The TELFARE device has an effective range of 1,200 meters.

L. System Can Employ Precision Gunnery Techniques. Precision gunnery techniques can be employed with the TELFARE device, but range is limited to 1,200 meters. The MILES can employ precision gunnery but the tank computer is off and there is no ballistic solution. Ammunition must be indexed and the sight laid on center of mass of the target. Precision gunnery can be employed with the BT-41.

M. System Can Employ Battlesight Gunnery Techniques. Comments in paragraph L above, pertaining to precision gunnery techniques, apply generally to the employment of battlesight techniques.

N. System Can Accommodate Night Sighting Equipment of the Tank on Which it is Used. TELFARE can be employed with night sighting equipment, but MILES and BT-41 are not generally effective during periods of poor visibility.

O. System Can Accommodate Boresighting and Zeroing of the Main Gun. TELFARE, MILES, and the BT-41 must all be boresighted with the sights of the tank. The combat boresight of the tank will probably be disturbed by the use of the devices, and it will need to be restored after these systems have been removed from the tank.

P. System is Operational in "Hot" and "Basic" Climatic Conditions. All systems are capable of operating in "basic" and "hot" climates.

Q. Simulate Tracer Burn and Impact Indication in Real Time for the Gunner. The TELFARE device which fires the Cal. 50 Armor Piercing Incendiary Tracer (AP-I-T) ammunition provides "tracer burn" and a small amount of "impact indication" upon striking the target. The MILES system does not provide "tracer burn" but does provide adequate "impact indication" upon striking the target. The BT-41 projects a trajectory path and thereby simulates a tracer burn. Thus, it provides an "impact indication" when striking the target.

R. Simulate Tracer Burn and Impact Indication in Real Time for the TC. The optical effect mentioned in paragraph Q can be provided to the TC by the BT-41 if required.

S. Simulate Flash, Bang, and Obscuration at Firing. The Caliber 50 machinegun of the TELFARE device provides flash and bang but no obscuration. For the MILES, blank rounds, blank firing adapters, and other flash/bang simulators present the firing signatures for the main gun. A limited amount of obscuration is achieved. The BT-41 also provides flash-bang and some obscuration.

T. Permit Controller to Assess Kills. When utilizing the TELFARE device the assessment of kills by the controller is dependent upon the controller's ability to sense the strike of a 50 caliber AT-I-T round in the target area. Both the MILES and BT-41 have a clearly discernible flash and puff of smoke on the target when it is hit.

U. Superimpose a Simulated Real Time Image Over Sight Picture. The BT-41 has a simulated superimposed real time image over the sight picture. The other weapons simulator systems do not have this feature.

V. Determine the Miss Distance. Miss distance determination using the TELFARE device is left to the gunner/TC to estimate while sensing. The MILES device indicates hit, near miss, or miss only. Accurate miss distance is indicated by the BT-41 system.

W. Record the Location of Round Impact Relative to the Optimum Aim Point, True Target Range, Crew Determined Target Range, Ammunition Indexed, Ammunition Fired, Cant, and Engagement Times. The BT-41 records location by round impact. The other weapons simulation systems do not indicate impact in relation to optimum aim point or true target range.

X. Display Number and Type of Hits Achieved, and Rounds Expended and Remaining. The BT-41 displays misses primarily in mils and secondarily in meters. It also displays rounds expended as well as rounds remaining. MILES displays hits and rounds remaining.

SUMMARY

An analysis of the comparative training capabilities of four tank gunnery training systems (devices) was undertaken using the data produced by two specially prepared matrixes.

The performance Elements Matrix (Appendix B) showed that, while most crew actions could be performed on all systems, each system was unable to accommodate certain task elements. For Dry Fire, the missing elements centered on sensing rounds and adjusting fire. For TELFARE, elements are not missing as much as they are modified. This pertains especially to loading-related tasks and to applying target lead. The MILES system also interferes with applying target lead. In addition, it interferes with loading, sensing rounds, and adjusting fire. Fewest missing or modified performance elements appear to result when the BT-41 is used. For this system, the affected elements center on loading-related tasks. Otherwise, the results of the comparison tend to be favorable to the BT-41.

The results from the System Criteria Matrix (Appendix C) tend to support these various findings. Because it uses only dummy rounds, Dry Fire training provides no feedback to the crew about impact of rounds; it is thus not a viable force-on-force training system. TELFARE also can't be used in force-on-force engagements because it uses live ammunition; it cannot be used with dynamic targets. The MILES system overcomes both of these defects, but introduces another. Since the tank computer is off, its "projectile" is a nonballistic one; normal lead must not be employed. In addition, normal sensing of round impact is not possible with MILES. Again the matrix results favor the BT-41. It satisfies the shortcomings of the other systems and seems to have only minor weaknesses. This device alone appears able to engage in force-on-force engagements so that there can be true round sensing and realistic flight times of projectiles.

With regard to future comparisons or experimental tests of the four systems the following conclusions are offered:

1. Dry Fire training is a viable training option only in cases where no other training alternative is possible. Dry Fire training is readily available to any armored unit commander as long as he has his TO&E authorized equipment and the time available. Since the other three systems are all special devices to improve upon Dry Fire Training, further comparisons with Dry Fire training are not needed.

2. The TELFARE device, a live-fire appendage to the tank, is used primarily to improve tank gunnery for the crew, without any intent for use in tactical training. Its comparison must be confined to the gunnery range training portion of the criteria in the TWGSS requirements document.

3. Further analysis of the comparative training capabilities of the SAAB BT-41 and the MILES systems is warranted. It should be guided by one major premise: The most important requirement for any training system is that it must develop skills for main gun firing that will transfer readily to the real system. Both the BT-41 and the MILES systems accommodate to some

extent, individual tank crew member duties as well as force-on-force unit tactical training. The degree of transfer of these tank skills to live firing should be included in the test concept for further evaluation. The MILES system has been employed by the Army in the field for over a year. Its capabilities and limitations are fairly well established. The SAAB BT-41 system is a concept worthy of comparative testing. Conceptual design descriptions and limited field application by the producer of the BT-41 indicate that it may provide a real step forward in tank gun simulation. Some areas of particular interest for comparison with the MILES system are discussed below.

a. The areas of target identification and the target acquisition appear to present no real difference among systems. Procedures followed for "initial lay" of the gun differ somewhat, however. With the MILES system the computer must be shut off and no ballistic solution is entered into the fire control system, ammunition must be indexed and the proper sight picture taken to accommodate the gunnery technique (battlesight or precision). A moving target can be tracked, but without proper lead angle. With the SAAB BT-41 system, the tank computer may be used.

b. After "initial lay" and firing, a difference in the two systems is again apparent in the task of "sensing." With the MILES system, target impact is indicated by a laser pulse reflecting from the target which transmits weapons effects to the tank crew by a buzzing tone over the intercom system; also produced is a blinking strobe light. These signals indicate near misses, hits and kills. Obviously a true sensing for subsequent adjustment cannot take place since the trajectory of the round and the exact strike are not observed. With the SAAB BT-41 device, the exact trajectory of the projectile in real time is simulated in the gunner's sight, thus providing an accurate sensing with which to apply BOT or otherwise adjust the fire of a subsequent round. Both systems employ laser pulses to strike the target, but only the SAAB BT-41 exhibits the exact location of the strike. Tracer burn and impact indication of the BT-41 appear to be a real asset.

c. Assessment of kills information available to controllers and crewmen in force-on-force engagements for use during critiques is another area in which comparison by testing may be needed. Analysis of the quality of training through measured performance appears to be attainable through the display assembly of the BT-41. The print out of "firing simulation data" and "received hits data" is worthy of comparison with the "feedback report" utilized by MILES.

TEST CONCEPT FOR A COMPARATIVE EVALUATION OF SAAB BT-41 AND MILES TRAINING DEVICES

Gunnery training programs and engagement simulation systems are needed that will integrate main gun gunnery and tactical skills into one program. While individual training in precision and battlesight gunnery is provided, the conduct of such training in the context of tactical training is greatly needed. Tank crews need explicit experience firing and using proper procedures against free moving, intelligently controled targets; further, this experience should be gained while crews operate under the danger of being destroyed themselves.

Currently under evolution is a Tank Weapons Gunnery Simulation System (TWGSS) concept. This system will develop, maintain, and objectively evaluate individual, crew, and unit proficiency in main gun skills, including their ability to boresight and zero. TWGSS is to provide realistic simulation of any main gun firing table to include individual, crew, platoon, company, and battalion exercises.

At present, two existing devices or simulation systems may satisfy the TWGSS concept requirements. A preliminary comparison of the SAAB BT-41, TELFARE, and MILES systems was recently made, based on available descriptive documentation. The results suggested that the BT-41 and MILES were the most likely candidates to satisfy the TWGSS. A need now is to undertake a more formal comparison of these devices, and a test concept is thus a first requirement. For convenience, it is recommended that the comparison be limited so that only the M60A1 tank is involved.

METHOD

Various training alternatives can be employed to establish gunnery and tactical skills. To evaluate the efficacy of the alternatives, a test concept is needed that will answer the following questions:

1. To what extent does each training alternative used in gunnery training (BT-41, MILES, TELFARE, Dry Fire) transfer to tactical performance?

2. What differences in tactical performance result when training alternatives BT-41 and MILES are used in learning tactics?

3. To what extent do the training alternatives used in tactics interfere with or augment gunnery skills?

A training design that will provide answers to these questions is shown in Table 1.

Table 1

Recommended Training Design

Phase[1]		Training Alternatives											
		Group I		Group II		Group III			Group IV				
Gunnery	Stationary Target	BT-41		MILES		TELFARE			Dry Fire				
	Moving Target	BT-41		MILES		TELFARE			Dry Fire				
Tactical	Platoon Training	BT-41	No Trng	MILES	No Trng	BT-41	MILES	No Trng	BT-41	MILES	No Trng		
	Force-on-Force (Offense)	BT-41	No Trng	MILES	No Trng	BT-41	MILES	No Trng	BT-41	MILES	No Trng		
	Force-on-Force (Defense)	BT-41	No Trng	MILES	No Trng	BT-41	MILES	No Trng	BT-41	MILES	No Trng		

[1]Testing will occur before and after each phase.

To assess the effects of tactical training on pure gunnery performance, provision is made so that a portion of each group will not experience tactical training. Subjects assigned to this condition will subsequently be compared with those who do receive the training. TELFARE and dry fire cannot be used for tactical training.

The design is arranged so that each phase of training will focus on specific task skills. The previous analysis (i.e., the comparison of BT-41, MILES, TELFARE and Dry Fire) indicated that the various training alternatives might be differentially capable of establishing such skills. Thus, the capability of the subjects to perform these skills after experiencing the various training alternatives will serve to evaluate the alternatives. Skills of interest and related training/testing events are shown in Table 2.

Table 2

Recommended Training/Testing Sequence

Phases		Events	Task Skills
Initial	Stationary Target	Pretest (Table VI, Sta, Live) Training Posttest (Table VI, Sta, Live)	Sense Impact, Apply BOT, Apply TC Adjustment
	Moving Target	Pretest (Table VI, Mvg, Live) Training Posttest (Table VI, Mvg, Live)	Sense Impact, Track, Lead, Adjust Fire
	Platoon Training	Pretest (Battlerun, Live) Training Posttest (Battlerun, Live)	All of above
	Force-on-Force	Pretest (Simulated Live Fire) Training Posttest (Simulated, etc)	All of above
Retest	Stationary Target	Posttest (Table VI, Sta, Live)	Same as listed above
	Moving Target	Posttest (Table VI, Mvg, Live)	Same as listed above

The training listed in Table 2 under "Events" will consist of the various training alternatives presented In Table 1. Note that each training phase begins with a pretest and ends with a posttest. Note also that all phases involve live fire testing except the Force-on-Force phase. It is assumed that crews are equivalent in tank gunnery skills prior to the first test.

Force-on-Force Phase

Each training group participating in this phase will be trained and tested in both offensive and defensive modes, using both the BT-41 and the MILES systems. The training and testing design for these groups may be made clearer by the illustration below.

Offensive Mode			Defensive Mode		
Pretest	Training	Posttest	Pretest	Training	Posttest
BT-41	BT-41	BT-41	BT-41	BT-41	BT-41
		MILES			MILES
MILES	MILES	MILES	MILES	MILES	MILES
		BT-41			BT-41

Half of each group, whether offense or defense, will be posstested with the equipment on which they were trained, and half with the opposite equipment. In all instances the OPFOR will operate with MILES equipment.

Implementation of this phase will require the preparation of several scenarios and the development of the necessary operations orders for the opposing forces. Guidance for the preparation of tank platoon missions is found in ARTEP 71-2 (3-IV-2 and 3-IV-3), dated November 1981. All missions in the scenarios should be oriented to the destruction of the enemy and not solely to the seizure or retention of a piece of terrain. The tactical setting should be such that opposing targets will vary in range from 500 to 2500 m.

Lateral limitations of the exercise should enable all platoons to be monitored by controllers; at the same time, the exercise should provide for free maneuvers. Controllers should prevent opposing tanks from closing within 100 m of each other. The mission of the offensive force will dictate the range to the targets, while the mission of the defensive force will determine the maneuver to be utilized.

This design assumes that appropriate receptors can be mounted on opposing tanks (i.e., BT-41 receptors on MILES equipped tanks and MILES receptors on BT-41 tanks). Any camouflage materials used on tanks should be prohibited from masking reflectors, reflective materials, or special receptors that are mounted on tanks.

While fixed numbers and types of engagements may not be feasible, each group participating in this phase should undergo the same number of exercises. It is recommended that a set of ten exercises be generated and employed with each group. The number of engagements undertaken in each exercise can vary, depending on the scenario and locations and types of targets.

Subjects

Implementation of this test concept will require a sizeable number of subjects. The requirements presented here are based on the following numerical assumptions: There are 5 tanks/platoon, 3 platoons/company, and 4 companies/battalion. Assignment of companies at random, one to each of the training conditions, would require a minimum of 10 companies. To be able to continue the evaluation in the face of various interruptions (turbulence), 12 companies or 3 battalions would represent a more realistic requirement.

It is planned to employ as subjects both the loader and gunner in each tank. Thus, based on the assumptions listed above, the total number of subjects would be 5 tanks x 3 platoons x 4 companies x 3 battalions x 2 personnel = 360. Since the loader and gunner will likely vary considerably in experience, scores of these individuals should be maintained and analyzed separately.

Test Performance Measures

Several test performance measures may be used both in the gunnery phases and in the tactical phases. These include the following:

Number of rounds used per engagement or target

Number of rounds sensed as Hits:
1st rd _____ 2nd rd _____ 3rd rd _____

Number of rounds sensed as Misses:
1st rd _____ 2nd rd _____ 3rd rd _____

Number of rounds sensed as Near Misses (MILES only):
1st rd _____ 2nd rd _____ 3rd rd _____

Number of rounds reported as Lost:
1st rd _____ 2nd rd _____ 3rd rd _____

Opening time

Engagement time

Additional test performance measures that may be recorded in the force-on-force phase include:

Number of targets engaged or re-engaged

Number of incoming rounds received while moving

Number of incoming rounds received while stationary that are:
_____ Hits _____ Near Misses (MILES) _____Misses

The force-on-force phase will also create opportunities for several non-gunnery assessments. These include per cent or number of first detections of the enemy, techniques used to adjust fire (especially MILES crews), efforts to conserve ammunition, techniques of leading employed by MILES crews, differences in performance as a function of speed of targets, differences in after-action reports, etc.

Analyses

The analyses to be undertaken should provide direct answers to the questions that were posed at the outset of this paper. The first question focused on transfer of skill from gunnery training to tactical performance. An analysis of scores of subjects on the pretest of the platoon training phase would constitute one source of information. Since there are 4 training alternatives and 1 test condition, a simple analysis of variance would be appropriate. The analysis could be performed on each of the scores (measures) previously listed. For example:

Platoon Training Phase

Measure: Number of Target Hits

Training Alternative During Gunnery Training	Platoon Training Pretest Score
BT-41	
MILES	
TELFARE	
Dry Fire	

To assess the transfer of gunnery training to force-on-force performance, the test scores of subgroups that received no training in the platoon phase as well as no training in the force-on-force phase could be evaluated. To see if there were interactions between gunnery training and force-on-force test scores, an analysis of variance that assumes repeated measures could be used. This analysis is depicted below.

Force-on-Force Training Phase (Offense)

Measure: No. of 1st Round Hits

Training Alternative During		Pretest	Posttest
Gunnery Trng	Tactical Trng		
BT-41	None		
MILES	None		

Similar analyses can be accomplished on the pretest and posttest scores of subjects in the force-on-force training phase, both offense and defense who did receive tactical training. Since the platoon training phase would have occurred, the number of training alternatives would be increased. The TELFARE and Dry Fire alternatives would be fractionated and subgroups formed. The following would depict one possible analysis.

Force-on-Force Training Phase (Offense)

Measure: No. of Rounds used per Engagement

Training Alternative During		Pretest	Posttest
Gunnery Trng	Tactical Trng		
BT-41	BT-41		
MILES	MILES		
TELFARE	BT-41		
TELFARE	MILES		
Dry Fire	BT-41		
Dry Fire	MILES		

This analysis would assess the combined effects of gunnery training and platoon training on tactical performance. The same analysis could be undertaken for each of several tactical performance measures for both offensive and defensive modes.

To answer the second question, which focuses on differences in tactical performance as a function of using BT-41 and MILES to learn tactics, portions of the previous analysis could be used. For example, one might look only at Groups I and II since their training involved only the BT-41 and MILES in learning tactics. For example:

Force-on-Force Training Phase (Defense)

Measure: Number of Targets Engaged or Re-engaged

Training Alternatives During Tactical Training	Pretest	Posttest
BT-41		
MILES		

To enable answers to the third question, which asks about the effects of tactical training on gunnery skills, the posttests of the stationary target and moving target phases are scheduled to be repeated (see Table 2). The analysis to be performed should involve all groups, including those that received no training or testing during the tactical phases. Again using one performance measure, the analysis would take this form:

Stationary Target Phase

Measure: Number of 1st Round Hits

Training Alternative During		Posttest 1	Posttest 2
Gunnery Trng	Tactical Trng		
BT-41	BT-41		
BT-41	No Trng		
MILES	MILES		
MILES	No Trng		
TELFARE	BT-41		
TELFARE	MILES		
TELFARE	No Trng		
Dry Fire	BT-41		
Dry Fire	MILES		
Dry Fire	No Trng		

In some instances, analyses of test performance may be undertaken in which the contribution of earlier test scores on subsequent test performance should be accounted for. In these cases, covariance analyses are the chosen procedures. Using the analysis above as a specific example, the performance of subjects on posttests 1 and 2 of the stationary target phase may be evaluated by using their pretest score as a covariate.

Numerous other analyses are possible, depending on the nature of the questions asked. For example, the force-on-force test scores of subjects who received no tactical training can be compared with subjects who did receive such training. Such analysis will help determine the extent to which subjects can learn tactical skills simply by undergoing tactical tests. If their performance on the various tests is no worse than that of subjects who had received tactical training, an obvious implication about the need for tactical training would result. The comprehensiveness of the design permits a wide array of analyses.

Equipment, Material, and Personnel

Equipment requirements may vary depending on the site at which the test is undertaken and the composition of participating organizations. The following is a general list of the most pertinent items:

1. Ranges appropriate for the several phases
2. 180 M60A1 tanks, with crews
3. Tank main gun ammunition
4. Targets appropriate for Table VI, training and testing
5. Targets appropriate for Table IX, training and testing
6. BT-41 devices for 2 tank companies (gunnery phase)
7. BT-41 devices for 3 tank companies (tactical phase)
8. MILES devices for 2 tank companies (gunnery phase)
9. MILES devices for 3 tank companies (tactical phase)
10. MILES devices for OPFOR (tactical phase)
11. TELFARE devices for 3 companies (gunnery phase)
12. TELFARE ammunition
13. Controllers for force-on-force phase
14. Retroreflectors and reflective materials for targets in gunnery phases
15. Appropriate receptors on targets in force-on-force phase

APPENDIX A

TRAINING ALTERNATIVE WITH TASKS AND TRAINING DEVICES

APPENDIX A. TRAINING ALTERNATIVE WITH TASKS AND TRAINING DEVICES

TRAINING DEVICES

TASKS AND TASK ELEMENTS	ESSLR				CESSLR				DRY FIRE Without LRF		DRY FIRE Unfiltered LRF	
	TELFARE		BREWSTER 1:5		MAIN GUN		TELFARE					
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Check Blister Cover Lock	X		X		X		X		X		X	
Clean LRF Lens	X[1]		X[1]		X[1]		X[1]		X		X	
Operating LRF												
Perform LRF Self Test	X		X		X		X		X		X	
Perform LRF Firing Test	X		X		X[2]		X[2]			X	X[2]	
Perform Malfunction Test 46	X		X		X[2]		X[2]			X	X[2]	
Perform Malfunction Test 47	X		X		X[2]		X[2]			X	X[2]	
Perform Malfunction Test 48	X		X		X[2]		X[2]			X	X[2]	
Perform Malfunction Test 49	X		X		X[2]		X[2]			X	X[2]	
Preparing to Fire 105mm Gun												
a. Normal Mode	X		X		X		X		X		X	
b. Degraded Mode	X		X		X		X		X		X	
Firing 105mm Gun												
Lay LRF Reticle on Target	X		X		X		X		X		X	
Track Moving Target	X		X		X		X		X		X	
Range to Target	X		X		X[2]		X[2]		X[3]		X[2]	
Evaluate Range Data	X[4]		X[4]		X[4]		X[4]			X	X[2]	
If Not Correct, Relay & Rerange to Target	X		X		X[2]		X[2]		X[5]		X[2]	
If Multiple Ranges, Select Desired Range	X[6]		X[6]		X		X		X[5]		X	
Fire Round	X		X		X		X		X[7]		X[7]	
Sense Round	X		X		X		X			X	X	
Relay on Target and Apply BOT	X		X		X		X		X[8]		X[8]	
Relay on Target and Apply TC Adjustement	X		X		X		X		X[8]		X[8]	

APPENDIX A. TRAINING ALTERNATIVE WITH TASKS AND TRAINING DEVICES (cont'd)

TRAINING DEVICES

TASKS AND TASK ELEMENTS	ESSLR TELFARE Yes	ESSLR TELFARE No	ESSLR BREWSTER 1:5 Yes	ESSLR BREWSTER 1:5 No	CESSLR MAIN GUN Yes	CESSLR MAIN GUN No	CESSLR TELFARE Yes	CESSLR TELFARE No	DRY FIRE Without LRF Yes	DRY FIRE Without LRF No	DRY FIRE Unfiltered LRP Yes	DRY FIRE Unfiltered LRP No
Boresighting 105mm Gun												
Lay on Target Aiming Point	X		X		X		X		X		X	
Range to Target	X		X		X[2]		X[2]		X[3]		X[2]	
Evaluate Range Data	X[4]		X[4]		X[4]		X[4]			X	X[2]	
If not Correct, Rerange to Target	X		X		X		X		X[5]		X	

NOTES: Yes, task can be performed; No, task cannot be performed.

The numbers in the colums correspond to the notes below:

1. If filter is mounted, it must be removed to clean LRF lens.
2. Task is possible only when on a laser-safe range.
3. Gunner can range to target but there is no feedback.
4. Presence or absence of multiple returns may depend on location of reflective materials on targets and how well gunner is able to lay on the materials.
5. Without range data, range to target can be estimated only.
6. It is uncertain at this time whether ESSLR will yield multiple returns.
7. Firing the round is simulated only.
8. Gunner can relay on target if he first lays off after firing is simulated.

APPENDIX B

PERFORMANCE ELEMENTS MATRIX

APPENDIX B. PERFORMANCE ELEMENTS MATRIX

CREW DUTIES (Tasks, Actions, Elements)	DRY FIRE			SAAB BT-41			MILES			TELFARE		
	YES	NO	NOTE	YES	NO	NOTE	YES	NO	NOTE	YES	NO	NOTE
Driver:												
Maintain Engine RPMs	X			X			X			X		
Lock Brakes	X			X			X			X		
Monitor Instrument Panel	X			X			X			X		
Respond to TC Movement Instructions	X			X			X			X		
Drive Tank Over Varied Terrain, Across Country	X			X			X			X		
Orient Front Slope Towards Target	X			X			X			X		
Maintain Steady Speed and Direction	X			X			X			X		
Alert Crew of Obstacles Anticipated	X			X			X			X		
Take Evasive Action to Avoid Enemy Fire			1			2			2			1
Seek Cover, Concealed, or Defilade Position			1			2			2			1
Loader:												
Search for Targets	X			X			X			X		
Arm Weapon with Main Gun Safety Switch	X			X			X					3
Announce "UP"	X			X			X			X		
Turn Turret Blower ON	X			X			X			X		
Prepare to Load Subsequent Round	X				X			X		X		
Operate Main Gun Safety Switch	X			X					4			4
Load Next Round			5		X			X				5
Arm Weapon System	X			X			X					3
Announce "UP"	X			X			X			X		
Repeat Above Sequence Under TC's Direction	X			X			X			X		
Turn Turret Blower OFF	X			X			X			X		
Check Replenisher Reservoir	X			X			X			X		

APPENDIX B. PERFORMANCE ELEMENTS MATRIX (Cont'd)

CREW DUTIES (Tasks, Actions, Elements)	DRY FIRE			SAAB BT-41			MILES			TELFARE		
	YES	NO	NOTE	YES	NO	NOTE	YES	NO	NOTE	YES	NO	NOTE
Tank Commander:												
Acquire/Identify Target (NOTE #6)	X			X			X			X		
Determine Most Dangerous Target, Issue Fire Command	X			X			X			X		
Direct Driver Toward Target	X			X			X			X		
Lay Gun for Direction	X			X			X			X		
Determine Range to Target												
a. Use Tank Mounted Rangefinder	X			X					7	X		
b. Estimate Range	X			X			X			X		
Command "FIRE"	X			X			X			X		
Fire Precision Engagement from TC Position (If Required)	X			X					8/9	X		
Fire Battlesight Engagement from TC Position (If Required)	X			X					8/9/10			11
Sense Round			12	X					12	X		
Issue Subsequent Fire Command			12	X					12	X		
Sense Target Hit		X		X				X		X		
Engage Multiple Targets												
a. Command "TARGET (RIGHT, LEFT, CENTER) TANK"	X			X			X			X		
b. Repeat Above Sequence Until All Targets Are Destroyed	X			X			X			X		
c. Command "TARGET, CEASE FIRE"	X			X			X			X		

APPENDIX B. PERFORMANCE ELEMENTS MATRIX (Cont'd)

CREW DUTIES (Tasks, Actions, Elements)	DRY FIRE YES	DRY FIRE NO	DRY FIRE NOTE	SAAB BT-41 YES	SAAB BT-41 NO	SAAB BT-41 NOTE	MILES YES	MILES NO	MILES NOTE	TELFARE YES	TELFARE NO	TELFARE NOTE
Gunner:												
Search and Acquire Targets	X			X			X			X		
Operate in Stabilized Mode	X			X			X			X		
Determine Range to Target If Required	X			X					7	X		
Operate Turret in Power	X			X			X			X		
Index Announced Ammunition	X			X			X					13
Turn On Main Gun Switch	X			X			X			X		
Identify Target (NOTE #6)	X			X			X			X		
Announce "IDENTIFIED"	X			X			X			X		
Track Target	X			X			X			X		
Take Up Proper Sight Picture (Apply Lead If Required)	X			X					8/9			8
Announce "ON THE WAY"	X			X			X			X		
Continue Tracking	X			X			X			X		
Fire Round Using Primary Sight for Battlesight Gunnery	X			X					8/9/10			8
Fire Round Using Primary Sight for Precision Gunnery	X			X					8/9			8
Fire Round Using Secondary Sight for Battlesight Gunnery	X			X					8/14			8/15
Fire Round Using Secondary Sight for Precision Gunnery	X			X					8/14			8/15
Sense Round		X		X				X		X		
Continue Tracking			12	X					12	X		
Relay on Target and Apply BOT			12	X					12	X		
Relay on Target and Apply TC Adjustment			12	X					12	X		
Announce "ON THE WAY"	X			X			X			X		
Fire Subsequent Round		X		X					16	X		
Sense Round		X		X				X		X		
Repeat Above Sequence Under TC's Direction Until "CEASE FIRE"	X			X			X			X		
Turn Main Gun Switch OFF	X			X			X			X		

APPENDIX C

SYSTEM CRITERIA MATRIX

APPENDIX C. SYSTEM CRITERIA MATRIX

CRITERIA	DRY FIRE YES	DRY FIRE NO	DRY FIRE NOTE	SAAB BT-41 YES	SAAB BT-41 NO	SAAB BT-41 NOTE	MILES YES	MILES NO	MILES NOTE	TELFARE YES	TELFARE NO	TELFARE NOTE
A System Can Be Used in Force-On-Force Gunnery Engagements.			1	X			X				X	
B System Can Be Tank Appended and Aligned By the Crew in One Hour.			3	X			X			X		
C The Tank Can Be Restored to Operational/Firing Condition in 1/2 Hour.	X			X			X			X		
D System Does Not Interfere With Normal Movement of Vehicle or Turret.	X			X			X			X		
E System Does Not Interfere With Performance of Crew Duties.	X					17			17			17
F Capable of Withstanding Both Hard Surface and Cross-Country Travel.	X			X			X			X		
G System Does Not Present a Health or Safety Hazard.	X			X			X					18
H Fire Upon Stationary and Moving Targets from a Stationary and Moving Tank.	X			X			X			X		
I Use or Simulate the Function of All Direct Fire Control Equipment.	X			X					8/9			8/13/15
J Operate Under the Same Visibility Conditions As the Tank Upon Which the System Is Used.	X			X			X			X		
K Operational Out to 3,000 Meters Under Ideal Conditions of Visibility.	X			X					19			20
L System Can Employ Precision Gunnery Techniques.	X			X					8/9			20
M System Can Employ Battlesight Gunnery Techniques.	X			X					8/9/10			20
N System Can Accommodate the Night Sighting Equipment of the Tank Upon Which the System Is Used.	X				X			X		X		
O System Can Accommodate Boresighting and Zeroing of the Main Gun.	X			X			X			X		

APPENDIX C. SYSTEM CRITERIA MATRIX (Cont'd)

CRITERIA	DRY FIRE YES	DRY FIRE NO	DRY FIRE NOTE	SAAB BT-41 YES	SAAB BT-41 NO	SAAB BT-41 NOTE	MILES YES	MILES NO	MILES NOTE	TELFARE YES	TELFARE NO	TELFARE NOTE
P System Is Operational in "HOT" and "BASIC" Climatic Conditions.	X			X			X			X		
Q Simulate Tracer Burn and Impact Indication in Real Time for the TC.		X			21			22			23/24	
R Simulate Tracer Burn and Impact Indication in Real Time for the Gunner.		X		X				22			23/24	
S Simulate Flash, Bang, and Obscuration At Firing.		X		X			X				23	
T Permit Controller to Assess Kills.		X		X			X			X		
U Superimpose a Simulated Real Time Image Over Sight Picture.		X		X				X			23	
V Determine the Miss Distance.		X		X				25		x		
W Record the Location of Round Impact Relative to the Optimum Aim Point True Target Range, Crew Determined Target Range, Ammunition Indexed, Ammunition Fired, Cant, and Engagement Times.		X		X				X			X	
X Display Number and Type of Hits Achieved, and Rounds Expended and Remaining.		X		X				25			X	

NOTES TO APPENDICES B AND C

1. No Hit/Miss Indication; Target Is Not Dynamic.
2. Force-On-Force Tactical Gunnery Provides Immediate Hit/Kill Information to Both Target and Attacker.
3. The Subtask Is Not Required for the Proper Operation of the Device.
4. Operation of the Main Gun Safety Switch Does Not Affect Gunner's Ability to Engage Targets, i.e., Since Main Gun Does Not Fire, the Safety Switch Does Not Move from the Fire Position to the Safe Position, Since a Main Gun Round Was Not Fired, the Loader Must Move the Switch Manually to the Safe Position Prior to Loading the Subsequent Round.

NOTES TO APPENDICES B AND C (Cont'd)

5. Main Gun Breech Is Open for Initial Engagement; Subsequent Dummy Round Can Be Loaded.
6. Includes Targets Varying in Range, Movement, Size, Shape, and Exposure Time.
7. TC or Gunner (If Required) Can Range But He Receives No Constructive Feedback As to Accuracy.
8. Target Can Be Tracked and Engaged, But Without Proper Lead Angle.
9. Although the Computer Is Off and No Ballistic Solution Is Entered Into the Fire Control System, Both Precision and Battlesight Gunnery Techniques Can Be Trained, i.e., Index Ammunition in the Computer and Lay Center of Mass or Base of Target As with Precision and Battlesight Engagements Respectively.
10. Due to the Characteristics of the Miles System (Computer Must Be Off) There Exists a Possibility That a Battlesight Engagement of a Fully Exposed Tank Has a Much Less Possibility of Being Hit Than a Tank Which Is Hull Defilade.
11. 1,000 Meters Must Be Indexed Into the Rangefinder Because the TELFARE Is Fired Off the HEP Cam.
12. Since Dry Fire and MILES Do Not Produce a Trajectory Or Strike of Round Impacting, No Sensing Or Subsequent Adjustment of Fire Can Be Made.
13. Gunner Can Index Ammunition, But It Must Be Hep and Not What the TC Has Announced.
14. Secondary Sight Can Be Used, But Must Be Used with a Predetermined Fixed Range Sight.
15. Gunner Can Use a Secondary Sight, But He Must Use the HEP Reticle.
16. Subsequent Round Can Be Fired, But Will Not Be Based on Observation of Sensing.
17. Some Duties of the Loader Can Not Be Performed.
18. Safety Requirements of Any Live Fire Weapons System.
19. Has a Kill Range Out to 2,400 Meters with "NEAR MISS" to 3,000 Meters.
20. Range Limited to 1,200 Meters.
21. Available As an Option If Required.
22. No Tracer Burn.
23. Simulation Not Required.
24. Uses 50 Cal. Armor Piercing Incendiary Tracer Ammunition (AP-I-T).
25. Indicates "HIT, NEAR MISS, and MISS" Only.